The EarthCARE mission, which is a collaborative project between the European Space Agency (ESA) and he Japan Aerospace Exploration Agency (JAXA) has been launched on May 28th, 2024. Over its estimated three-year lifespan, EarthCARE's instruments will collect unprecedented data on the transmission of energy in Earth's atmosphere, which will enhance our understanding of how clouds and aerosols affect Earth's energy budget. Aerosol-cloud interactions (ACI) is the largest uncertainty in our climate projections. To address this uncertainty, EarthCARE will provide three-dimensional data to improve the representation of clouds and aerosols in global weather and climate models. EarthCARE will provide us with new and improved aerosol and cloud products, in particular over remote areas, which are particularly important for understanding clouds will interact with clouds across the scales in the *post-fossil* regime.

CleanCloud will benefit highly from EarthCARE. We will quantify aerosol concentrations and types in the vicinity of clouds using vertical profiles of aerosol extinction, backscatter, and depolarization from ATLID. EarthCARE's Doppler radar, lidar and multi-spectral imager will provide accurate vertical profiles of cloud phase, ice water content, vertical motions, rain rates, particle size, and extinction with quantified uncertainties. CleanCloud will use these products to constrain aerosol emissions and properties, cloud properties, and ACI processes in models at different scales.

A unique objective of CleanCloud is to develop new retrieval algorithms to obtain information of key processes such as the signatures of ice multiplication, retrievals of in-cloud vertical velocities for characteristic cloud regimes and characteristic aerosol types (like bioaerosol) that can promote ice formation in clouds. We will develop and further improve cloud radar remote sensing algorithms that provide insights on the microphysical processes active especially ice multiplication, which is one of the least constrained of cloud processes, can strongly modulate the magnitude and extent of ACI in warm mixed-phase clouds. Vertical air motions will be incorporated in the parameter space of the obtained aerosol and cloud statistics, paving the way to an improved unravelling of dynamical and aerosol-related effects on cloud processes. We will test these new and improved retrieval algorithms on EarthCARE data and against detailed datasets obtained from dedicated field campaign experiments in the Arctic (Villum research station) and the Mediterranean (Mount Helmos, Greece).

Finally, CleanCloud will constrain the uncertain processes in kilometer- and larger-scale models to reduce the uncertainties in climate projections by integrating observations from multiple sources with models. The uncertain parameter space will be constrained by the new satellite observations of aerosol, cloud, and precipitation by EarthCARE, combined with other satellites, such as the recently launched PACE.